

# The European Space Sciences Committee

***1 November 2017  
SSB Meeting, Irvine, CA***

*Athena Coustenis, ESSC Chair  
Nicolas Walter, ESSC Executive Secretary*

## The European Science Foundation Hosts Scientific Expert Boards and Committees

Composed of high-level independent researchers or research managers to provide targeted expert advice in areas of science, policy, infrastructure, environment and society in Europe:

- Nuclear Physics European Collaboration Committee (NuPECC)
- European Space Sciences Committee (ESSC)
- Committee on Radio Astronomy Frequencies (CRAF)

## International Environment

### European Union

- H2020 Space Advisory Group (individuals)
- Horizon 2020 stakeholder consultations
- Direct interactions with programme executives

### National Space Agencies

- Annual meeting with ESSC Funding Organisations
- UKSA's SPAC
- Swedish national committee

### ESA

- Council at Ministerial level
- High-level Science Policy Advisory Committee (ex-Officio)
- Scientific advisory committees at programme level (ex-Officio)
- Meetings with programme executives

- COSPAR Science Advisory Committee (ex-Officio)
- Observer status to UN COPUOS in progress

- US National Academies Space Studies Board
- CAS/NSSC and CAST
- JAXA
- IKI

- 15 organisations (space agencies, research councils) from 13 European Countries
- Some of the countries/institutions represented
  - ASI/Italy
  - ESA
  - Norges Forskningsrad/Norway
  - Swedish National Space Board
  - CNES/France
  - Academy of Finland
  - UK Space Agency
  - .....





- **ESSC Plenary** meeting: 31 May- 2 June 2017, Athens, Greece
- **ESA SSAC** meetings : 30-31 May; 25-26 Oct 2017, ESA HQ, ESAC
- **ESA HESAC** meetings : 27 Jan, 13 April, 8 Sep, 13 Oct. 2017, ESTEC
- **International Space Policy** for EU integration : 14-15 June, Rome, Italy
- **International Airshow** (ESA presentation of the E3P program) : 20 June, Le Bourget, Paris
- **Science is global** : 27 June, European Parliament
- Contributions to **ESA strategy Department**
  - **Diversity / inclusiveness policy** consultation (with E. Vaudo-Scarpetta, Head of Policy) 6 June
  - Space 4.0 program: **Industry-Academia relations** (with P. Messina, Member States Office) : 28 Sept. 2017

- **Space Weather Assessment and Consolidation Working Group** (lead: H. Opgenoorth): 28-29 June, Darmstadt, Germany + Follow-up meeting in November 2017 and 2018
- **European Space Week 2017 – EC Space InfoDay**: 8-9 Nov. 2017, Tallinn, EE, G. Paar represents ESSC in panel discussion
- **Exoceans study** (lead: A. Coustenis): 13-14 November, Paris, FR – SSB CAPS Members participating
- **Intl Moon Village Workshop** : 19-21 Nov, ISU, Strasbourg, FR (M. Anand)
- **Copernicus Support Office and Users Forum Meeting** : 27 Nov., Brussels, BE, (A. Coustenis, P. Veefkind, N. Walter)

**ESSC Chair:** Athena Coustenis, Paris Observatory and CNRS, France

**Life and Physical Sciences in Space**

**Panel Chair:** Dominique Langevin, Université de Paris-Sud, France

- Sarah Baatout, Belgian Nuclear Research Centre (SCK-CEN), Belgium
- Alexander Chouker, Hospital of the Ludwig-Maximilian University, Germany
- Berndt Feuerbacher, DLR, Germany
- Helen Fraser, The Open University, United Kingdom
- Anne Pavy Le Traon, University Hospital of Toulouse, France
- Roberto Piazza, Milano Politecnico, Italy
- Peter Preu, DLR, Germany
- Hubertus Thomas, DLR, Germany

**Solar System Exploration**

**Panel Chair:** Hermann J. Opgenoorth, Swedish Institute of Space Physics, Sweden

- Mahesh Anand, The Open University, United Kingdom
- Ester Antonucci, Torino Observatory of Astronomy, Italy
- Luisa M. Lara Lopez, Instituto de Astrofísica de Andalucía -CSIC, Spain
- Franck Montmessin, CNRS, France
- Karri Muinonen, University of Helsinki and National Land Survey, Finland
- Gerhard Paar, Joanneum Research, Austria
- Petra Rettberg, DLR, Germany
- Robert Wimmer-Schweingruber, University of Kiel, Germany

**Earth Sciences**

**Panel Chair:** Ian Brown, Stockholm University, Sweden

- Laurence Eymard, Université Pierre et Marie Curie, France
- Andreas Käab, University of Oslo, Norway
- Maarten Krol, University of Wageningen, Netherlands
- Rosemary Morrow, LEGOS, France\*
- Sindy Sterckx, VITO, Belgium
- Pepijn Veefkind, Royal Netherlands Meteorological Institute, Netherlands

**Astronomy and Fundamental Physics**

**Panel Chair:** Stéphane Udry, Université de Genève, Switzerland

- Conny Aerts, Katholieke Universiteit Leuven, Belgium
- Nabila Aghanim, IAS-CNRS, France\*
- Paolo De Bernardis, Rome "La Sapienza" University, Italy
- Chris Done, University of Durham, United Kingdom
- Michael Perryman, North University College, United Kingdom
- Manolis Plionis, National Observatory of Athens, Greece\*
- Alexander Tielens, Leiden Observatory\*
- Jordi Torra, Universitat de Barcelona, Spain

*“ The mission of the ESSC is to provide an independent voice on European space research and policy. It is the ESF’s expert body on space research ”*



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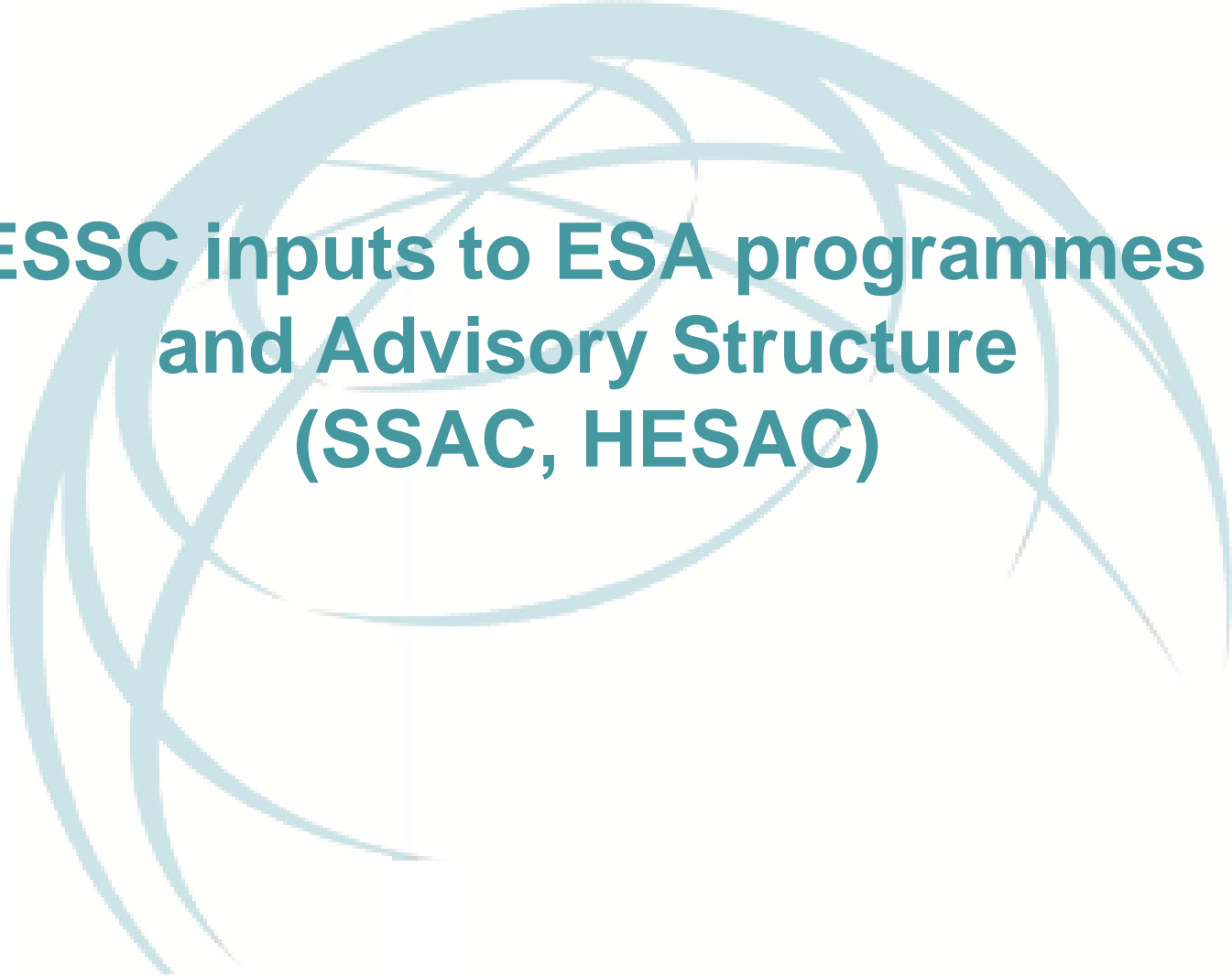
## 35 Members

## 21 men/14 women

- Laurence Eymard, Université Pierre et Marie Curie, France
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# ESSC inputs to ESA programmes and Advisory Structure (SSAC, HESAC)

## Interactions with ESA

- Interactions with DG and ESA Directors
- Participation to HESAC and SSAC meetings
- Contribution and participation to the ESA Council at Ministerial Level in Luzern, Switzerland, 1-2 Dec. 2016 and statement on the outcome and follow-up plans
  - ESSC Recommendations and advice on the ESA programmes after the CMIN 2016
    - **Science Mandatory programme**
    - **Human and Exploration programme**
    - **Earth Observations programme**
    - **Space Situation Awareness programme**

# Basics of the SCI and HSRE Programmes



- **The Programmes are Science-driven and exploratory:**

both long-term science and exploratory planning ; mission or experiment calls are bottom-up processes, relying on broad community input, advisory structure and peer review.

- **The Science Programme is Mandatory:**

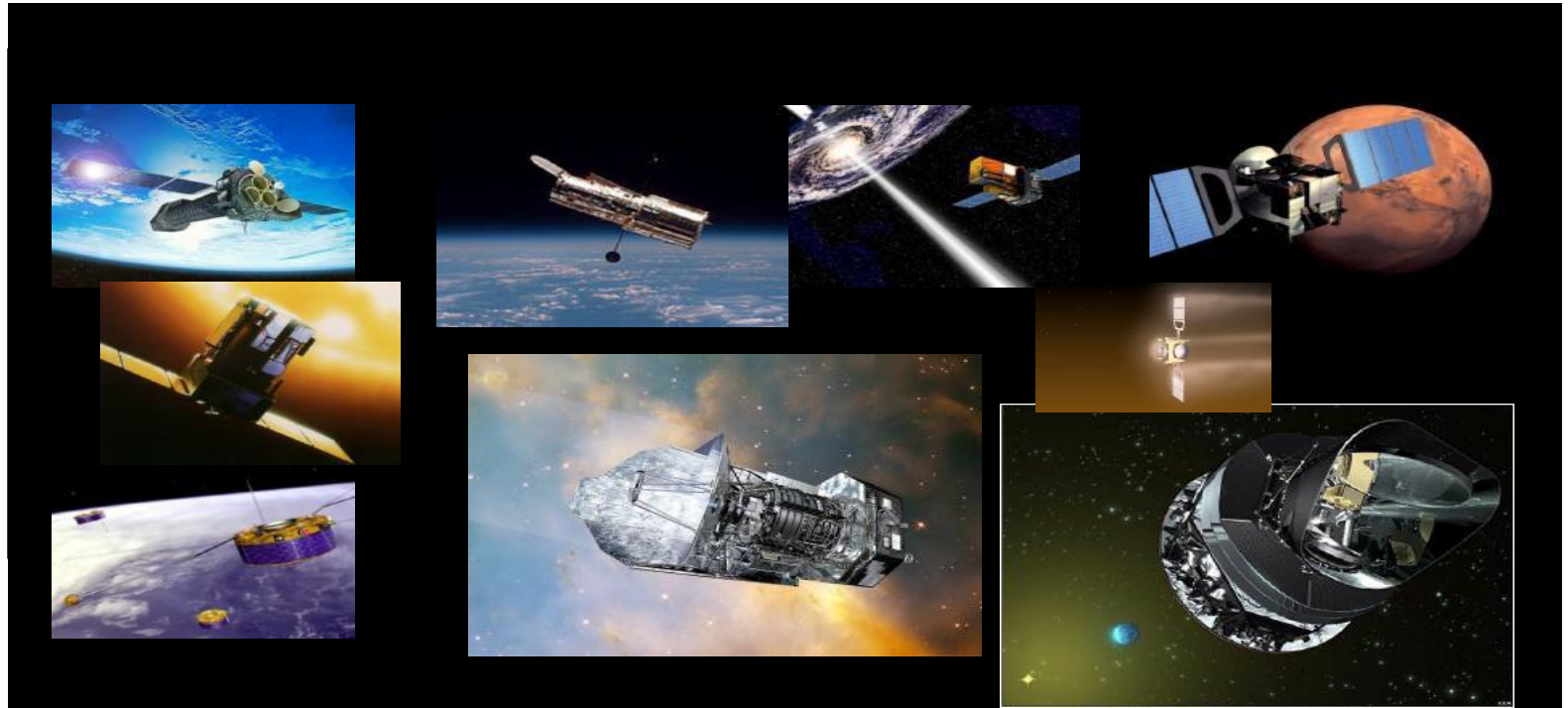
all member states contribute pro-rata to GDP providing budget stability, allowing long-term planning of its scientific goals and being the backbone of the Agency.

- **The Human Spaceflight and Robotic Exploration Programme is optional:**

17 countries and Canada contribute. E3P encompasses ISS, astronauts, Orion, Moon and Mars destinations ...



# ESA Science Mandatory Programme



- To enable the European scientific community to achieve and sustain excellence in science through a cutting-edge scientific programme meeting the challenges of worldwide research.
- To be a pillar in the creation and maintenance of space skills and capabilities for Europe, including advanced technologies, key for the competitiveness of European industry on the worldwide scene.
- To fascinate, inspire and motivate European citizens.



## Successes and objectives of the science mandatory programme

- Based on peer-reviewed selection of missions on the basis of scientific excellence following an open call. The content of the Programme (which missions?) is decided by the SPC (national delegates).
- Long-term planning to service a broad community with the annual budget over 4-5 years decided at ESA Council at Ministerial level.
- Regular sequence of launches based on a balance of mission sizes (Small, Medium, Large), fostering both ambitious, high-return missions and faster, smaller missions.
- Solid partnership with National programmes in Member States.
- Open to broad international cooperation

# Human and Robotic Exploration Programme: European Exploration Envelope (E3P) Proposal



## Europe's Space Exploration Vision



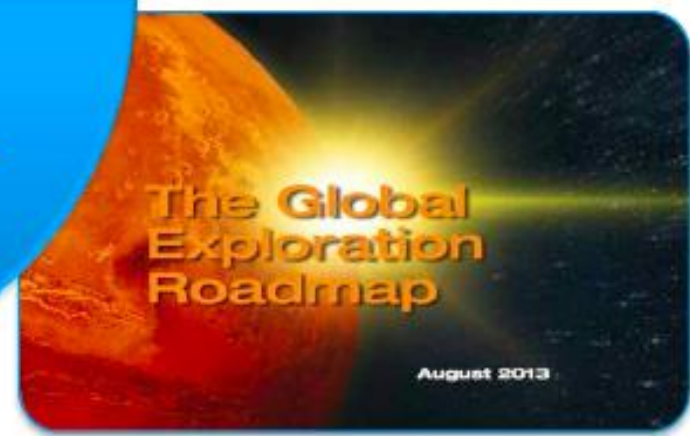
• **Basic & applied science**



• **New skills and technology**



• **Aspirational role models**



**The Global Exploration Roadmap**

August 2013

## Strategic guidelines of E3P

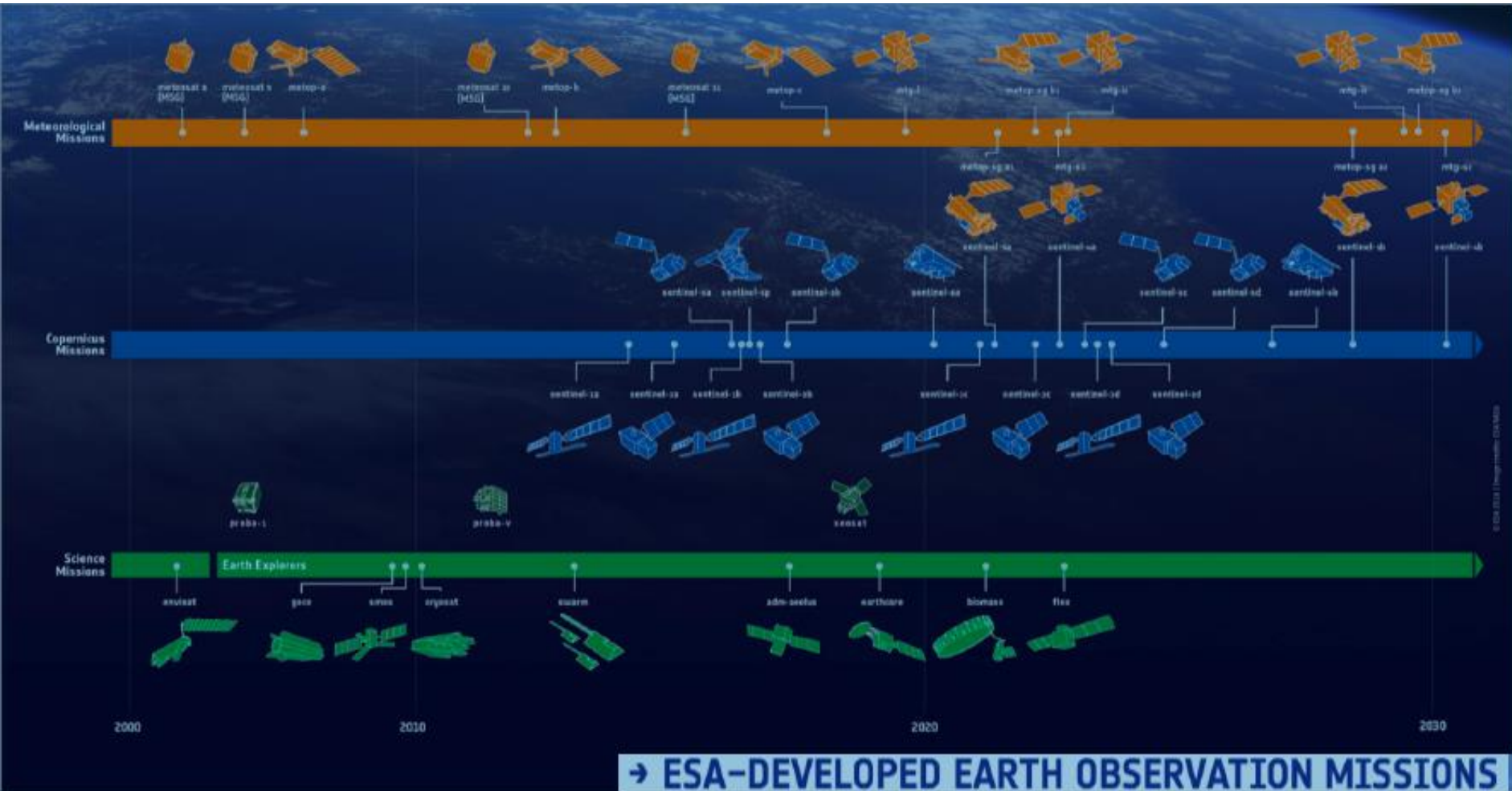
- Balanced mix of human and robotic
  - ***Robots as Human precursors***
- Secure maximum benefit from existing investments
  - ***ISS and ExoMars***
- Progressively develop new technological and operational capabilities
- Prepare future steps for beyond LEO sustained human presence
  - ***Moon as most likely next destination***
- Seek new opportunities for international cooperation
  - ***Maintain NASA as core partner***

# Activities in Period 1 financial envelope

Areas	Activites
<b>ISS</b>	<ul style="list-style-type: none"> <li>• ISS Operations until 2019</li> <li>• Finalisation of Orion ESM-FM1; procurement, assembly and testing of ESM FM 2 (barter element)</li> <li>• Start of complementary barter on Deep Space Habitat</li> </ul>
<b>ExoMars</b>	<ul style="list-style-type: none"> <li>• 2016 mission and science operations (after end of nominal science)</li> <li>• 2020 mission full implementation: development, integration, testing</li> </ul>
<b>Luna-Resource Lander</b>	<ul style="list-style-type: none"> <li>• Implementation of Phase C/D/E of PILOT</li> <li>• Implementation of Phase C/D/E of PROSPECT</li> <li>• Implementation of Ground operation support</li> </ul>
<b>SciSpacE</b>	<ul style="list-style-type: none"> <li>• Science support activities (Topical Teams, Application promotion)</li> <li>• Development ISS experiment facilities, instruments, cartridges, inserts</li> <li>• Hardware and mission cost of non-ISS platforms, including ground-based facilities, parabolic flights, sounding rockets and ESA participation in BION-M2</li> </ul>
<b>ExPeRT</b>	<ul style="list-style-type: none"> <li>• Mission studies (up to Phase B1) with focus on Mars Sample return and Phobos Sample Return</li> <li>• Technology preparation for human and robotic missions</li> <li>• Preparation of new international collaborations</li> <li>• Spaceship EAC /Harwell Robotics and Autonomy Facility</li> <li>• At least one commercial partnership implemented</li> </ul>



# ESA Earth Observation programme



© ESA 2024. Programmes: DLR/ESA





# ESA Earth Observation programme

- Meteosat meteorological satellites since 1997
- ERS and ENVISAT: Earth's changing environment and climate
- ESA's Living Planet Programme for Science:
  - Earth Explorers (break-through technology in observing techniques while addressing key scientific challenges)
  - Earth Watch
- Copernicus Space Component:
  - Sentinels for long-term climate datasets (Sentinel 2B just launched)

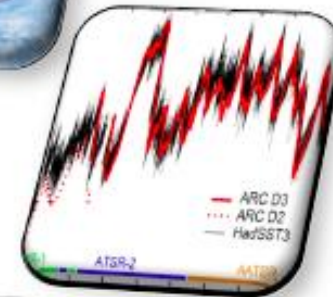
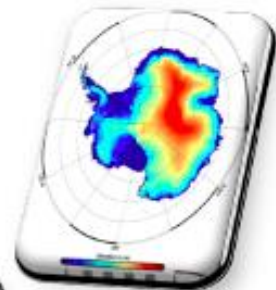
# ESA Earth Observation programme



## EOEP-5 (2017-2021)

### EO backbone programme to implement ESA's Space 4.0

- Addresses societal challenges (climate, water, food, SDG, etc.)
- Enhances competitiveness of European space, ground and services industry
- From pre-development to exploitation
- Prepares all future missions
- Drives scientific excellence and innovation
- Improved, user-ready data access
- Brings EO to all levels of society



# ESSC position on the outcome of ESA C-MIN

- ESA DG *Towards Space 4.0 for a United Space in Europe*. calls for a united and collaborative spirit across Europe and embraces a holistic approach to foster European identity, spirit and cohesion through excellence in space sciences and technology. It also sets the scene for an **improved coordination between ESA and the European Union** institutions
- Welcomed that **ExoMars is secured** - the benefits of separate budgets between mandatory and optional activities is highlighted
- Although rather high overall funding level, there is a **concern** about the fact that the interplay between the 1% increase and the contribution to ExoMars **will not allow for the scientific programme to compensate the inflation over the 2017-2021 period.**

# ESSC position on the outcome of ESA C-MIN



- Welcomed that the European Exploration Envelop Programme (E3P) concept is approved, however **regrettably the SciSpace element underfunded**
- EO - welcomed the level of funds allocated to the EarthWatch elements, but regret that the 5<sup>th</sup> phase of the **Earth Observation Envelop Programme has been underfunded by approximately 18%**
- SSA - Regrets that the **SSA programme has been underfunded by more than 50%** - It is also clear that SSA is an issue of common interest between ESA and the European Commission

**Space science is not a cost, it is a high-return investment with a broad and exciting leverage effect on the people and the economy.**

## Outcome of CMIN

### Ongoing inputs within the ESA Advisory Structure and discussions on CMIN follow-up

- Concerns about delays in development, adoption and launch dates for several future missions, the CV program is sliding and the science community is worried. Stakeholders are sceptical...
- Ideas for putting the program back on the trail:
  - Reduced mission extensions after prioritisation
  - Cancellation of M6
  - Better control of contractor's activities



An infographic showing the orbits of various ESA spacecraft around the Sun. The Sun is on the left, and the orbits of Mercury, Venus, Earth, Mars, Jupiter, and Saturn are shown as blue arcs. Various spacecraft are placed along these orbits. Labels for each mission include the name in red and a brief description in white. The ESA logo is in the bottom left, and the title 'ESA'S FLEET IN THE SOLAR SYSTEM' is at the bottom center.

**soho**  
Facing the Sun

**venus express**  
Studying Venus' atmosphere

**juice**  
Studying Jupiter's icy moons

**bepicolombo**  
Exploring Mercury

**proba-2**  
Observing coronal  
dynamics and solar eruptions

**cassini-huygens**  
Studying the Saturnian system  
and landing on Titan

**exomars**  
Europe's new era of  
Mars exploration

**mars express**  
Investigating the Red Planet

**solar orbiter**  
The Sun up close

**cluster**  
Measuring Earth's magnetic shield

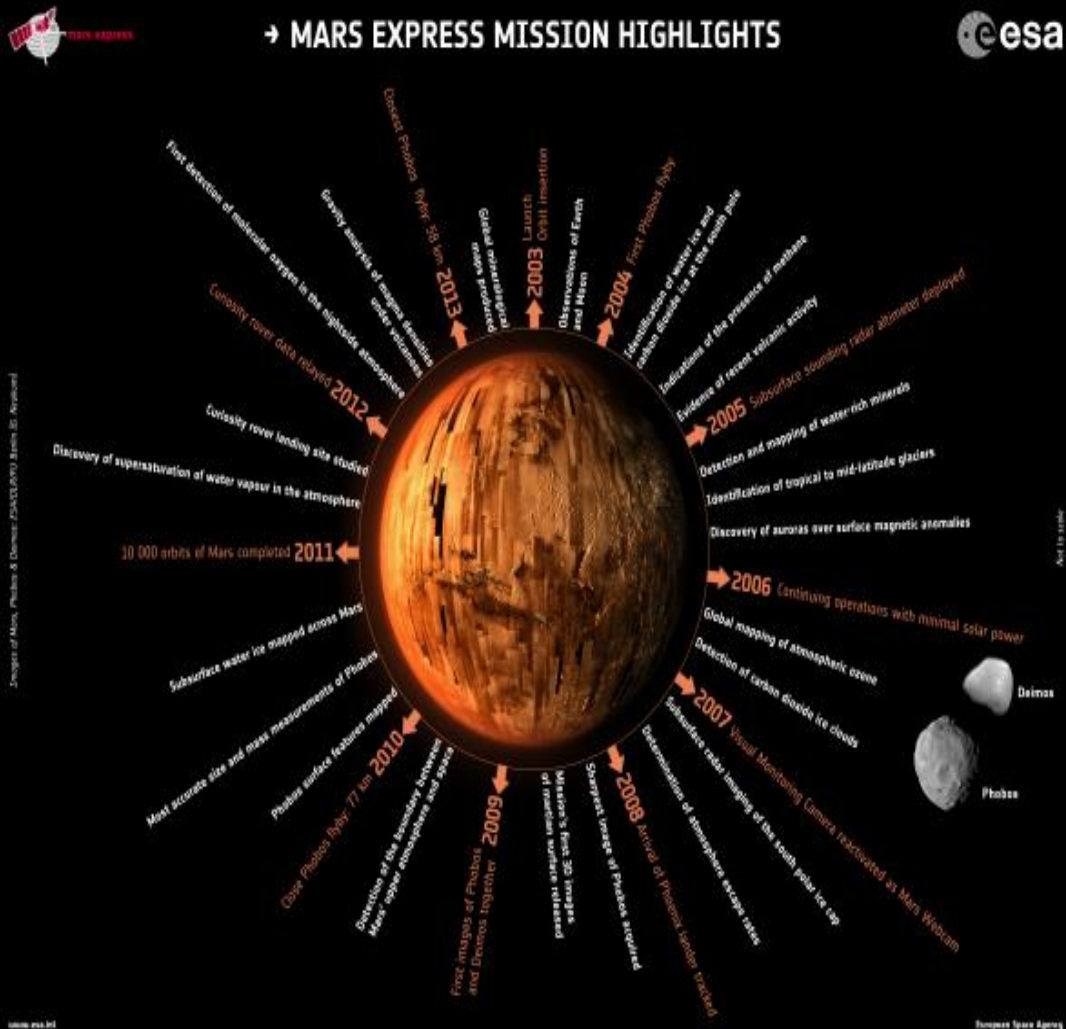
**rosetta**  
Chasing a comet



## → ESA'S FLEET IN THE SOLAR SYSTEM

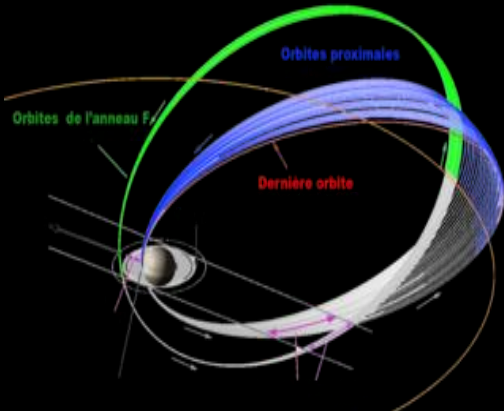
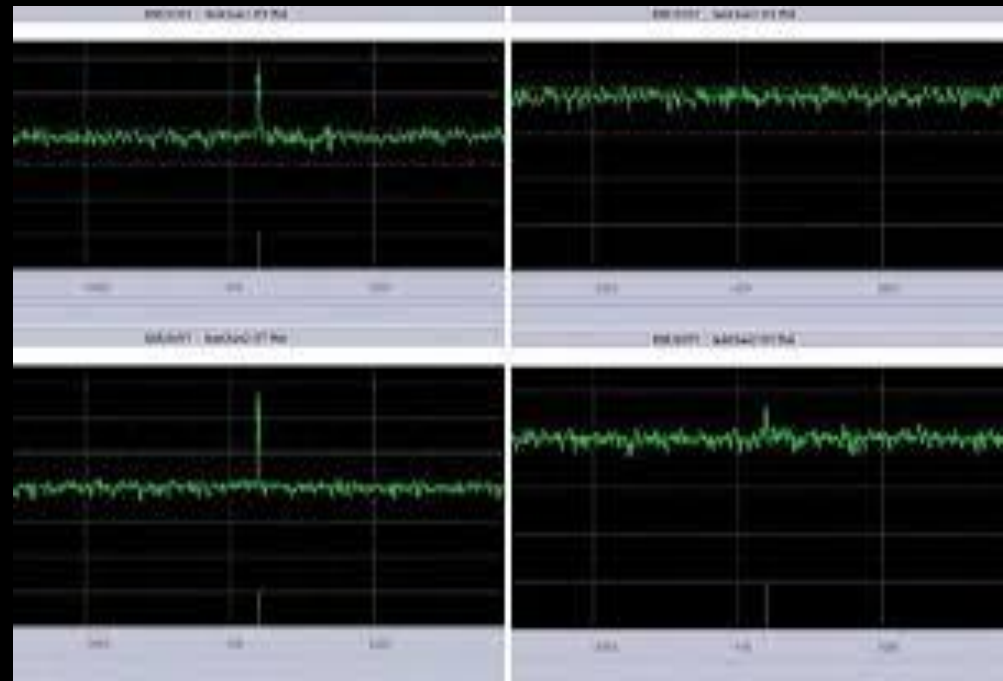
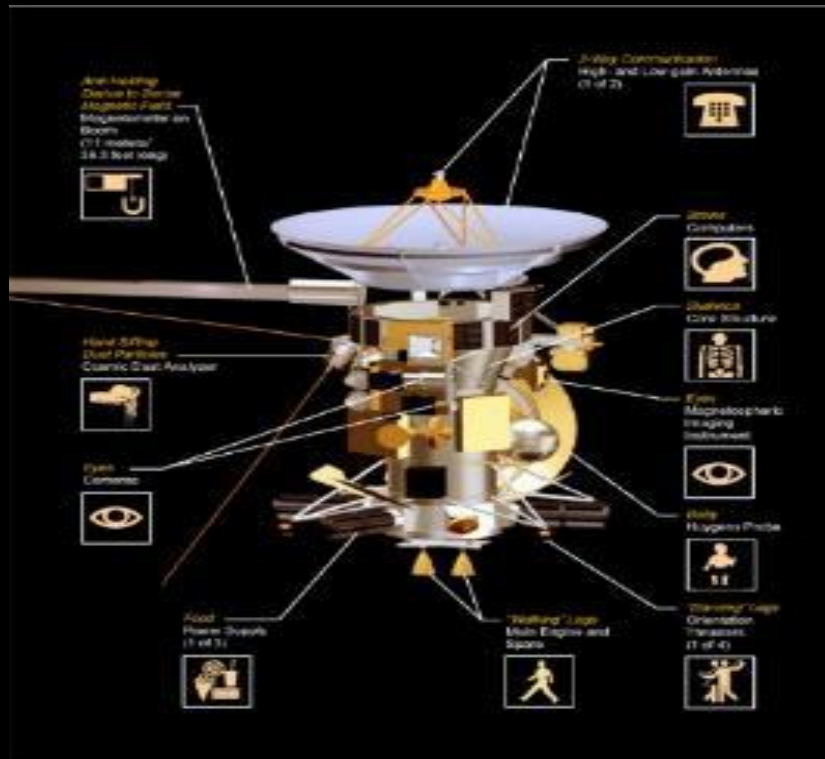
The Solar System is a natural laboratory that allows scientists to explore the nature of the Sun, the planets and their moons, as well as comets and asteroids. ESA's missions have transformed our view of the celestial neighbourhood, visiting Mars, Venus, and Saturn's moon Titan, and providing new insight into how the Sun interacts with Earth and its neighbours. The Solar System is the result of 4.6 billion years of formation and evolution. Studying how it appears now allows us to unlock the mysteries of its past and to predict how the various bodies will change in the future.

1. Hydrated minerals – evidence of liquid water on Mars
- #2. Possible detection of methane in the atmosphere
- #3. Identification of recent glacial landforms
- #4. Probing the polar regions
- #5. Recent and episodic volcanism
- #6. Estimation of the current rate of atmospheric escape
- #7. Discovery of localised auroras on Mars
- #8. Mars Express discovers new layer in Martian ionosphere
- #9. Unambiguous detection of carbon dioxide clouds
- #10. Mapping and measuring Phobos in unprecedented detail

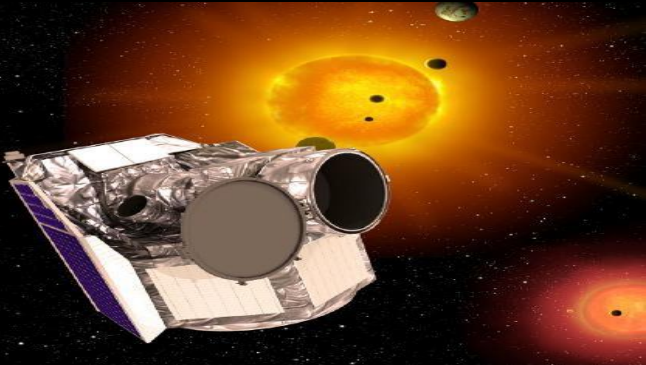




# 15 Sept. 2017: Cassini Grand Finale



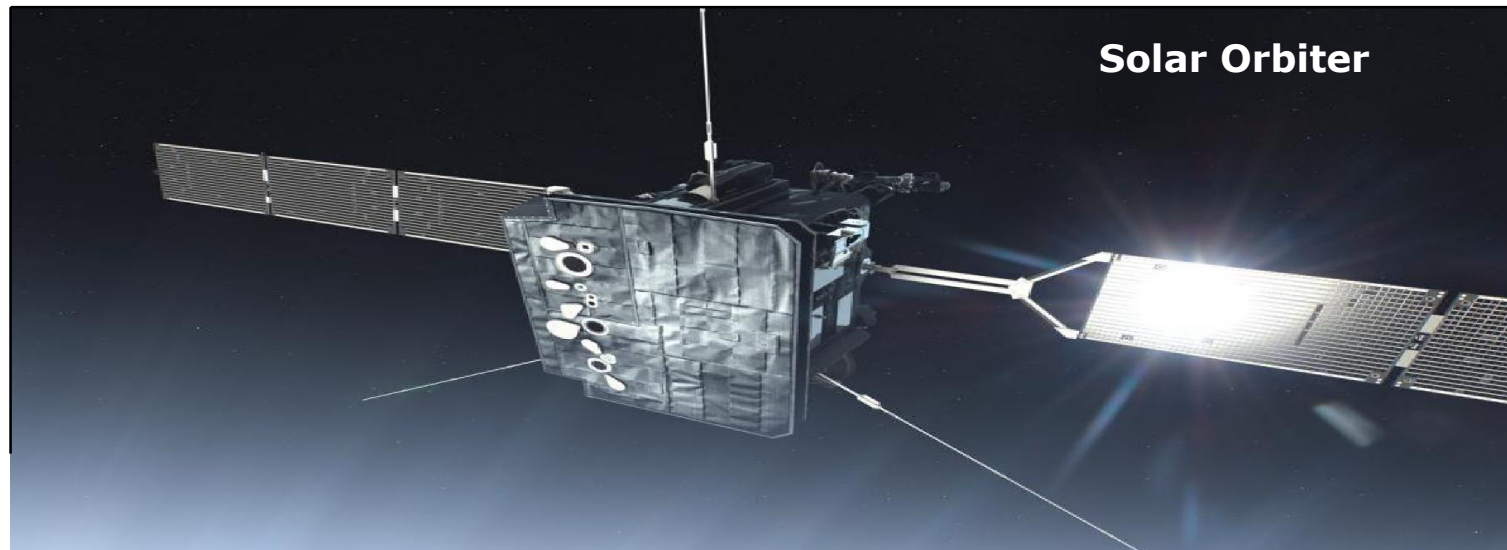


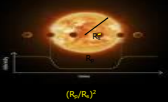
# FUTURE MISSIONS (S1, M1)



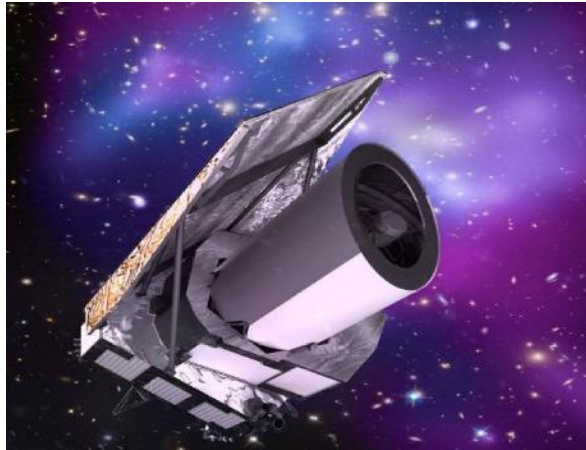
## CHEOPS

CHaracterising ExOPlanets Satellite

An ESA "S-class" mission, in partnership with Switzerland, to search for exoplanet transits of bright stars already known to host exoplanets using ultrahigh precision photometry.



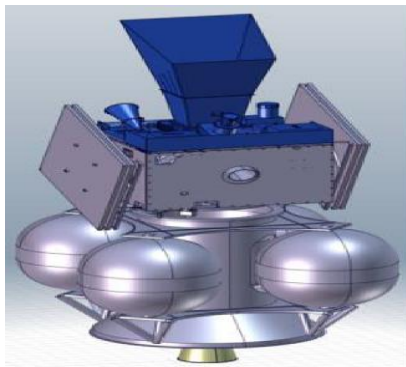
# EUCLID



Mission to understand the nature of dark energy and dark matter

- imaging of cosmic structures at different ages of the Universe to see the accelerated expansion during its lifetime.
- Investigating the structures formed by both dark matter and baryonic (luminous) matter using different measurement techniques.
- Survey of 36% of the sky in the visible

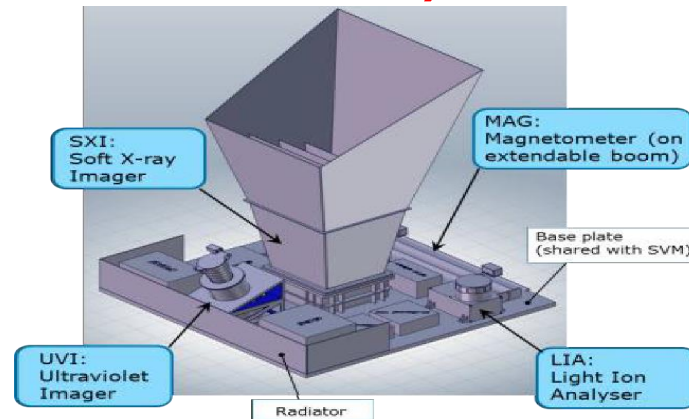
# SMILE (ESA-CAS mission)



PLM  
(ESA)

SVM  
(CAS)

PM  
(CAS)





# BepiColombo: Closing in on Mercury



**J**oint ESA/JAXA mission, and first dual- satellite enterprise to Mercury. First European mission to orbit a planet in the hot regions of the Solar System.

Consists of two individual orbiters:

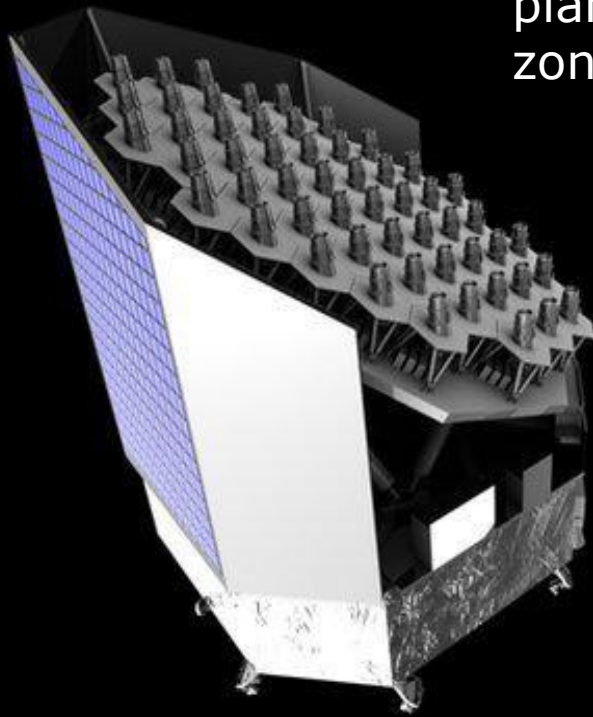
- the Mercury Planetary Orbiter (MPO) to map the planet, and
- the Mercury Magnetospheric Orbiter (MMO) to investigate its magnetosphere developed by JAXA.

*Launch in October 2018 with 9 planetary flybys and arrival to Mercury in December 2025.*

*Mercury / MESSENGER / NASA*

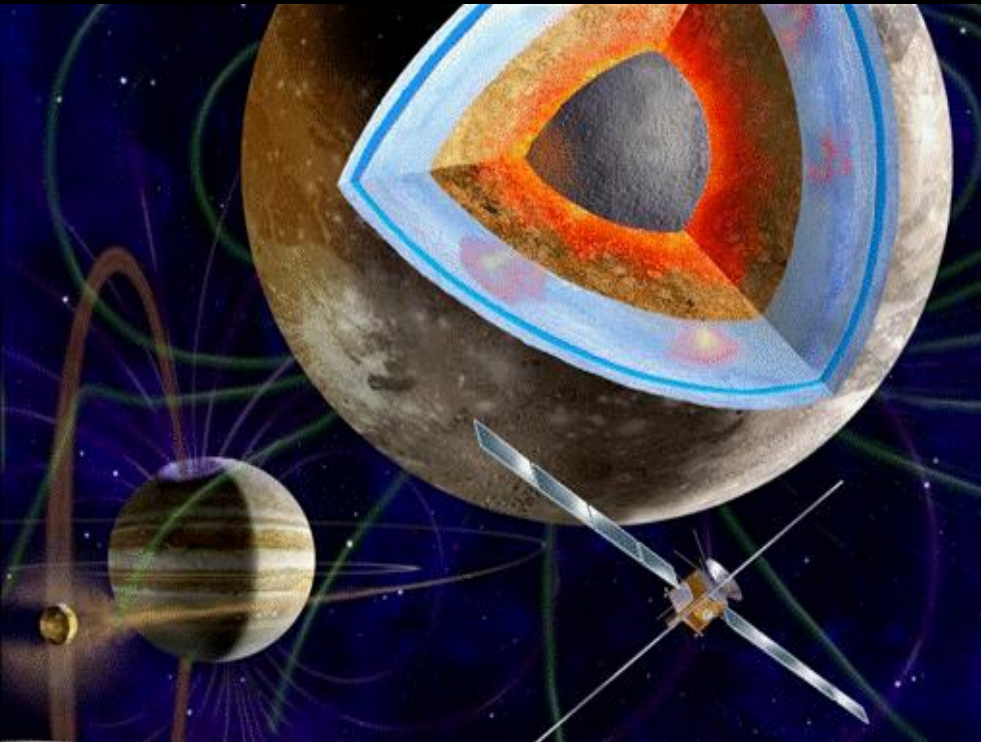
# PLATO (M3)

Detection and characterisation of terrestrial exoplanets around bright solar-type stars, with emphasis on planets orbiting in the habitable zone.



TAS

# JUICE: JUpter Icy moons Explorer

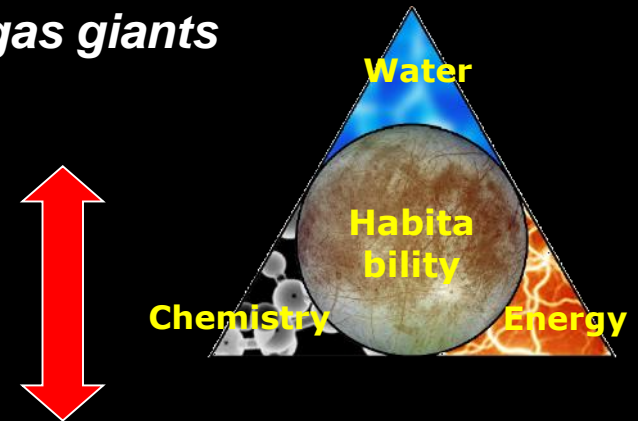


## JUICE : the 1<sup>st</sup> Large CV mission concept

- *Single spacecraft mission to the Jovian system*
- *Investigations from orbit and flyby trajectories*
- *Synergistic and multi-disciplinary payload*
- *European mission with international participation*

## JUICE Science Goals

- *Emergence of habitable worlds around gas giants*
- *Jupiter system as an archetype for gas giants*



## Cosmic Vision Themes

- *What are the conditions for planetary formation and emergence of life?*
- *How does the Solar System work?*

# JUICE Payload

Acronym	PI	LFA	Instrument type
<b>Remote Sensing Suite</b>			
<b>JANUS</b>	P. Palumbo	Italy	Narrow Angle Camera
<b>MAJIS</b>	Y. Langevin G. Piccioni	France Italy	Vis-near-IR imaging spectrometer
<b>UVS</b>	R. Gladstone	USA	UV spectrograph
<b>SWI</b>	P. Hartogh	Germany	Sub-mm wave instrument
<b>Geophysical Experiments</b>			
<b>GALA</b>	H. Hussmann	Germany	Laser Altimeter
<b>RIME</b>	L. Bruzzone	Italy	Ice Penetrating Radar
<b>3GM</b>	L. Iess	Italy	Radio science experiment
<b>PRIDE</b>	L. Gurvits	Netherlands	VLBI experiment
<b>Particles and Fields Investigations</b>			
<b>PEP</b>	S. Barabash	Sweden	Plasma Environmental Package
<b>RPWI</b>	J.-E. Wahlund	Sweden	Radio & plasma Wave Instrument
<b>J-MAG</b>	M. Dougherty	UK	Magnetometer



# Exploration of the Jupiter system

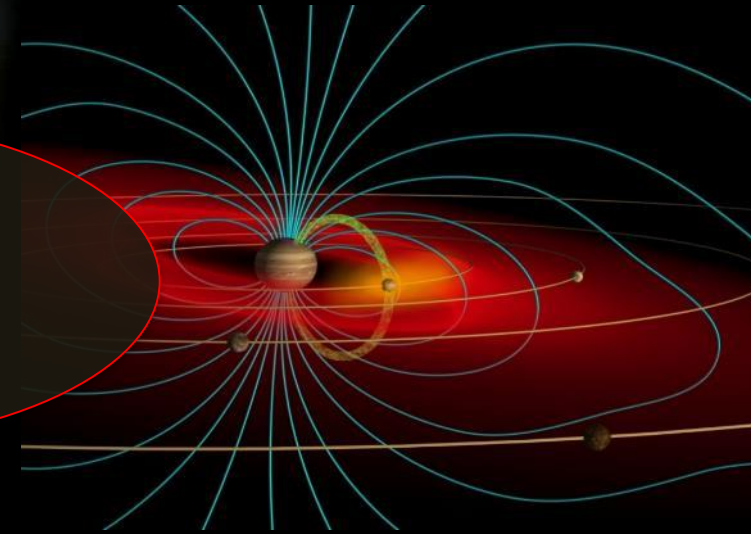
The biggest planet, the biggest magnetosphere, and a mini solar system

## Jupiter

- Archetype for giant planets
- Natural planetary-scale laboratory for fundamental fluid dynamics, chemistry, meteorology,...
- Window into the formational history of our planetary system

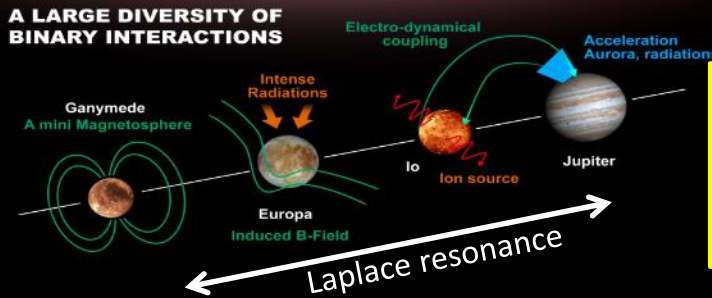
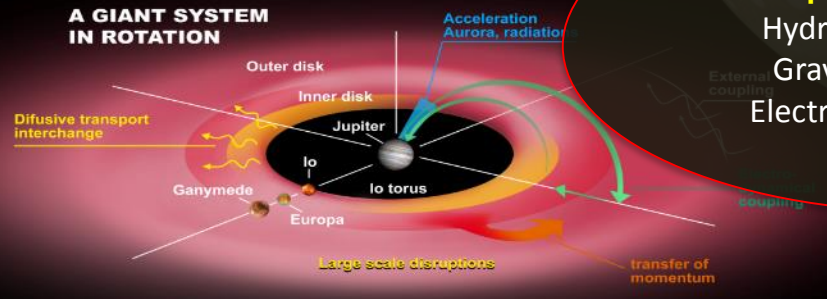
## Magnetosphere

- Largest object in our Solar System
- Biggest particle accelerator in the Solar System
- Unveil global dynamics of an astrophysical object



## Coupling processes

- Hydrodynamic coupling
- Gravitational coupling
- Electromagnetic coupling



## Satellite system

- Tidal forces: Laplace resonance
- Electromagnetic interactions to magnetosphere and upper atmosphere of Jupiter



# → ESA'S FLEET ACROSS THE SPECTRUM



Thanks to cutting edge technology, astronomy is unveiling a new world around us. With ESA's fleet of spacecraft, we can explore the full spectrum of light and probe the fundamental physics that underlies our entire Universe. From cool and dusty star formation revealed only at infrared wavelengths, to hot and violent high-energy phenomena, ESA missions are charting our cosmos and even looking back to the dawn of time to discover more about our place in space.

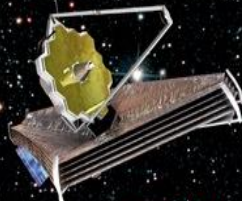
**planck**  
Looking back  
at the dawn of time



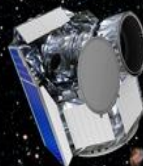
**herschel**  
Unveiling the cool  
and dusty Universe



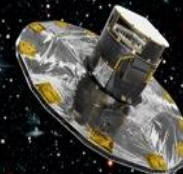
**just**  
Observing the first light



**cheops**  
Chasing and sizing exoplanets



**gaia**  
Surveying a billion stars



**euclid**  
Probing dark energy, dark matter  
and the expanding Universe



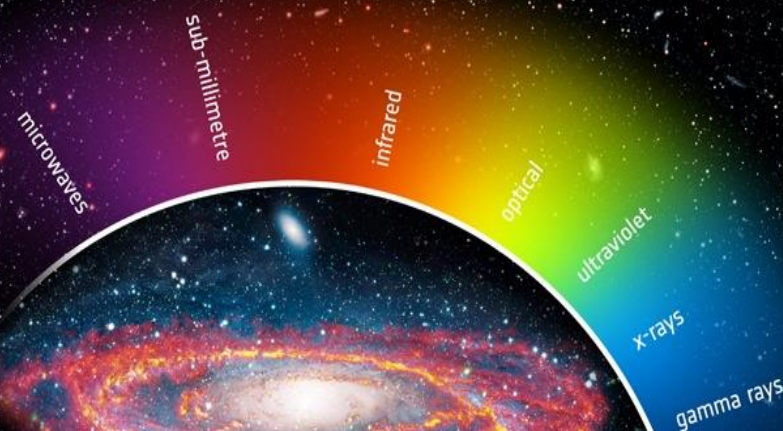
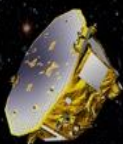
**hst**  
Expanding the frontiers  
of the visible Universe



**xmm-newton**  
Seeing deeply into the hot  
and violent Universe



**lisa  
pathfinder**  
Testing the technology  
for gravitational  
wave detection

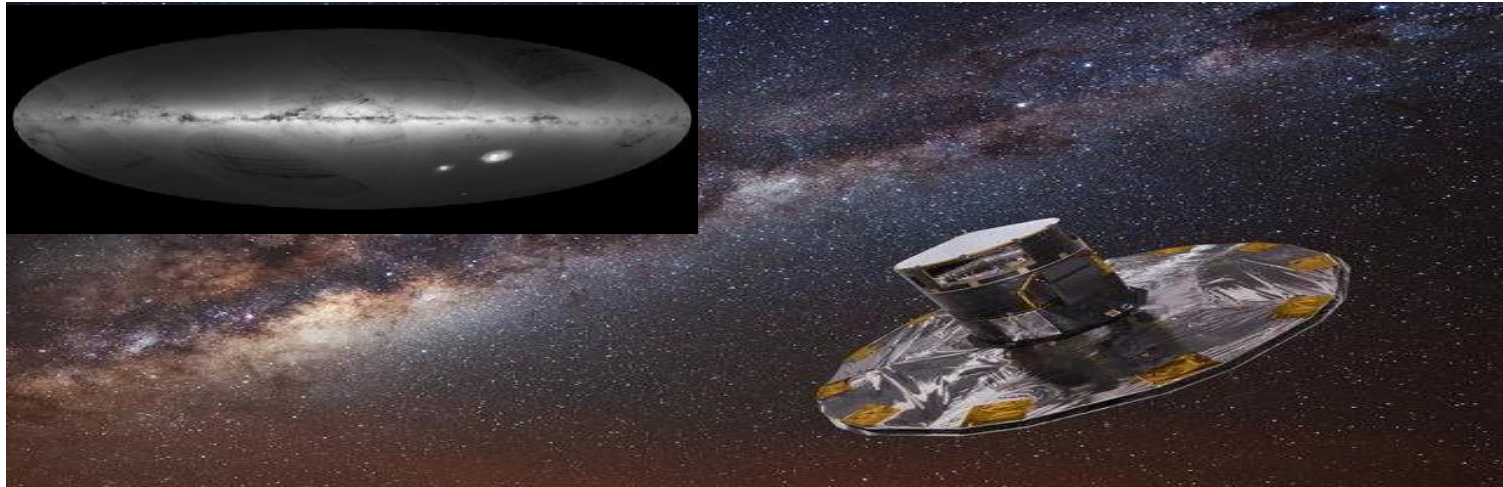


**integral**  
Seeking out the extremes  
of the Universe





# GAIA



## Progress towards Gaia first data release

Measurements as of September 2016: 490  
billion positions  
118 billion brightnesses  
10 billion spectra

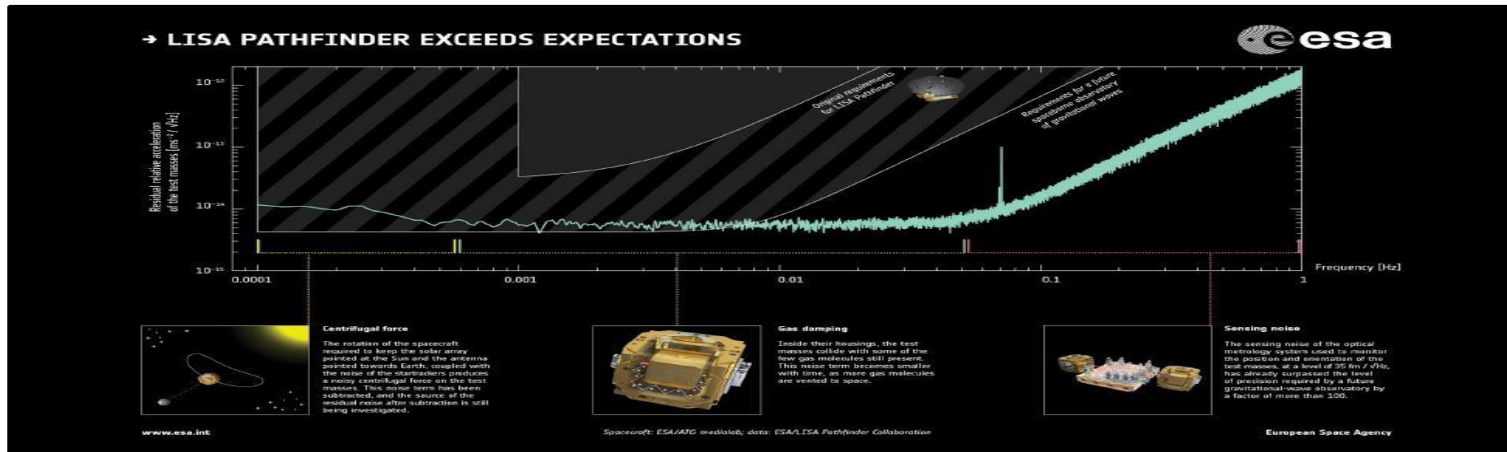
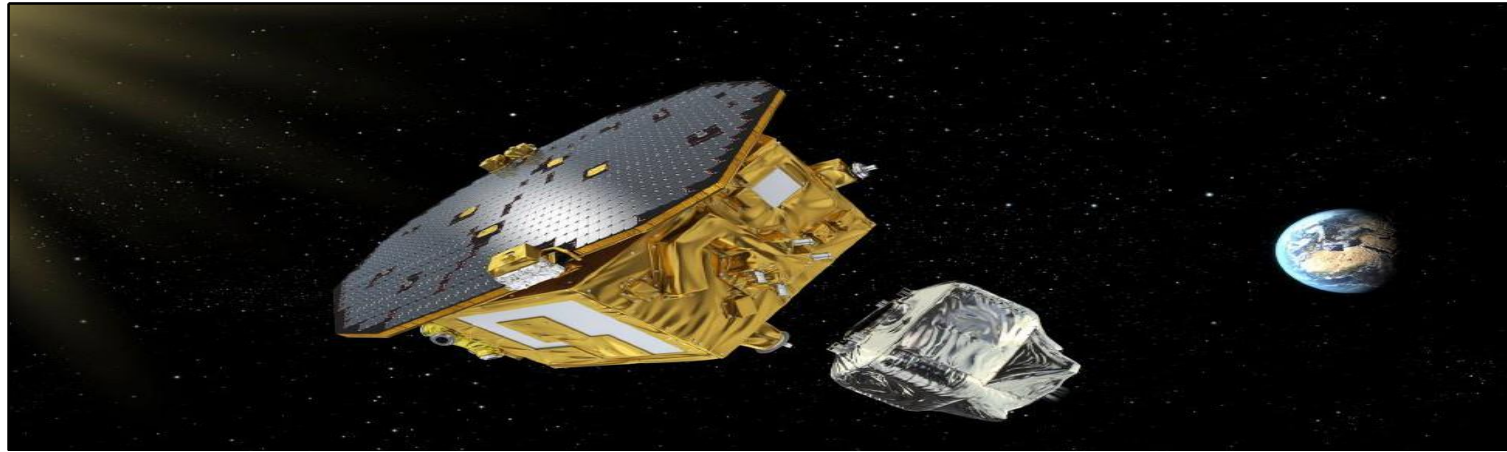
**First public data release in September 2016:** Positions &  
broad-band photometry for ~1 billion stars

Positions, parallaxes, & proper motions  
for 2 million stars in common with Tycho catalogue  
Selected RR Lyrae & Cepheid light curves

## Next data release in 2017:

Full astrometric solution for ~1 billion stars,  
including parallaxes & proper motions

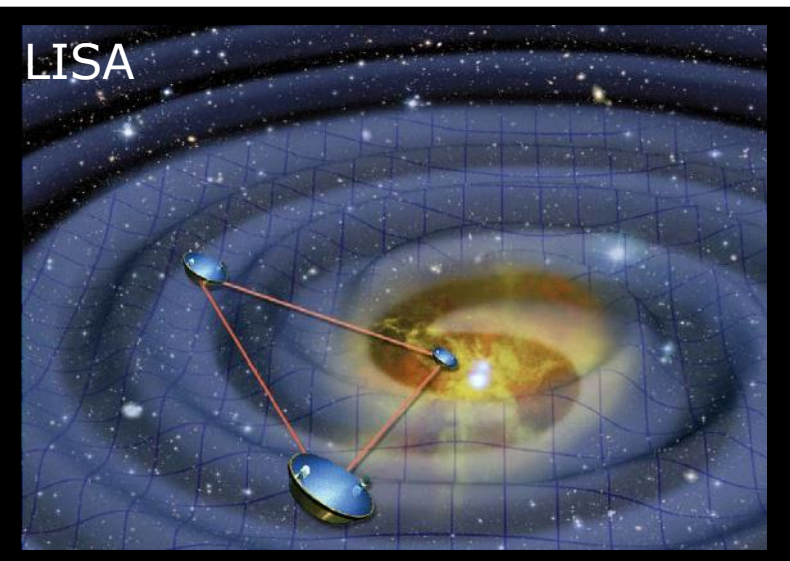
# LISA PATHFINDER



# FUTURE L2 and L3 ESA CV MISSIONS



**ATHENA** is a next-generation facility to address some of the most fundamental questions in astrophysics and cosmology by investigating black holes and matter under extreme conditions, the formation and evolution of galaxies, clusters and the large scale structure, and the lifecycles of matter and energy. Launch in 2028.



The **LISA Gravitational wave Observatory** is a space mission designed to measure gravitational radiation over a broad band at low frequencies, from about  $100 \mu\text{Hz}$  to 1 Hz, a band where the Universe is richly populated by strong sources of gravitational waves. It will benefit from the results of the LISA Pathfinder mission. Launch in 2035.

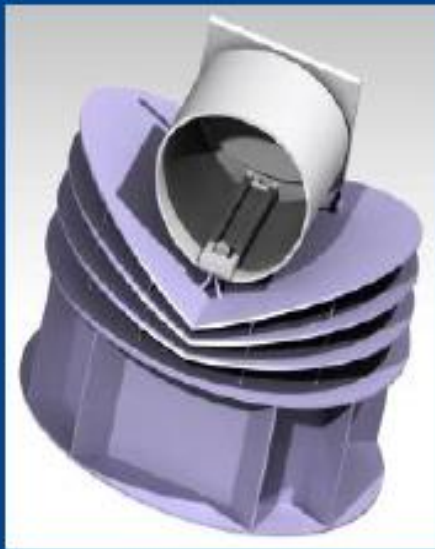


# COSMIC VISION (2015-2025)

## Step 2

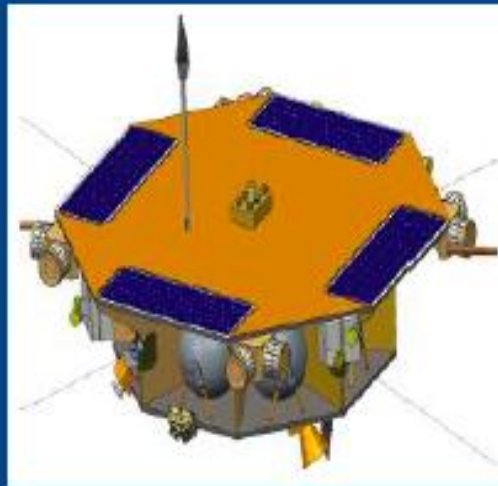
- Pre-selected M4 missions for study

### M4 Candidate Missions



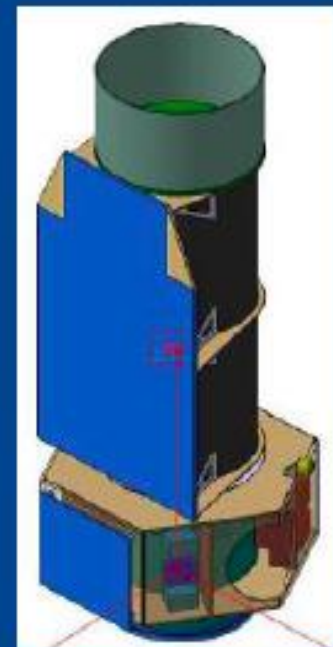
**ARIEL**

*Exoplanet atmosphere spectroscopy in the IR ( $\lambda = 2-8 \mu\text{m}$ ) for hot transiting planets. L2 orbit.*



**THOR**

*Understanding turbulent fluctuations in plasmas. Spinning S/C, in High Elliptic Orbit.*



**XIPE**

*Observatory for measuring the polarization of X-ray sources. LEO equatorial orbit 550 km*

# COSMIC VISION (2015-2035)

L3  
**LISA**

M7

M6

Probably cancelled

**CHEOPS**  
S-missions  
& MoO  
  
Astro-H  
Microscope

M5

M4

ARIEL  
THOR  
XIPE

M3  
PLATO

M2  
EUCLID

+  
Junior  
Partnership  
In other  
partner  
missions

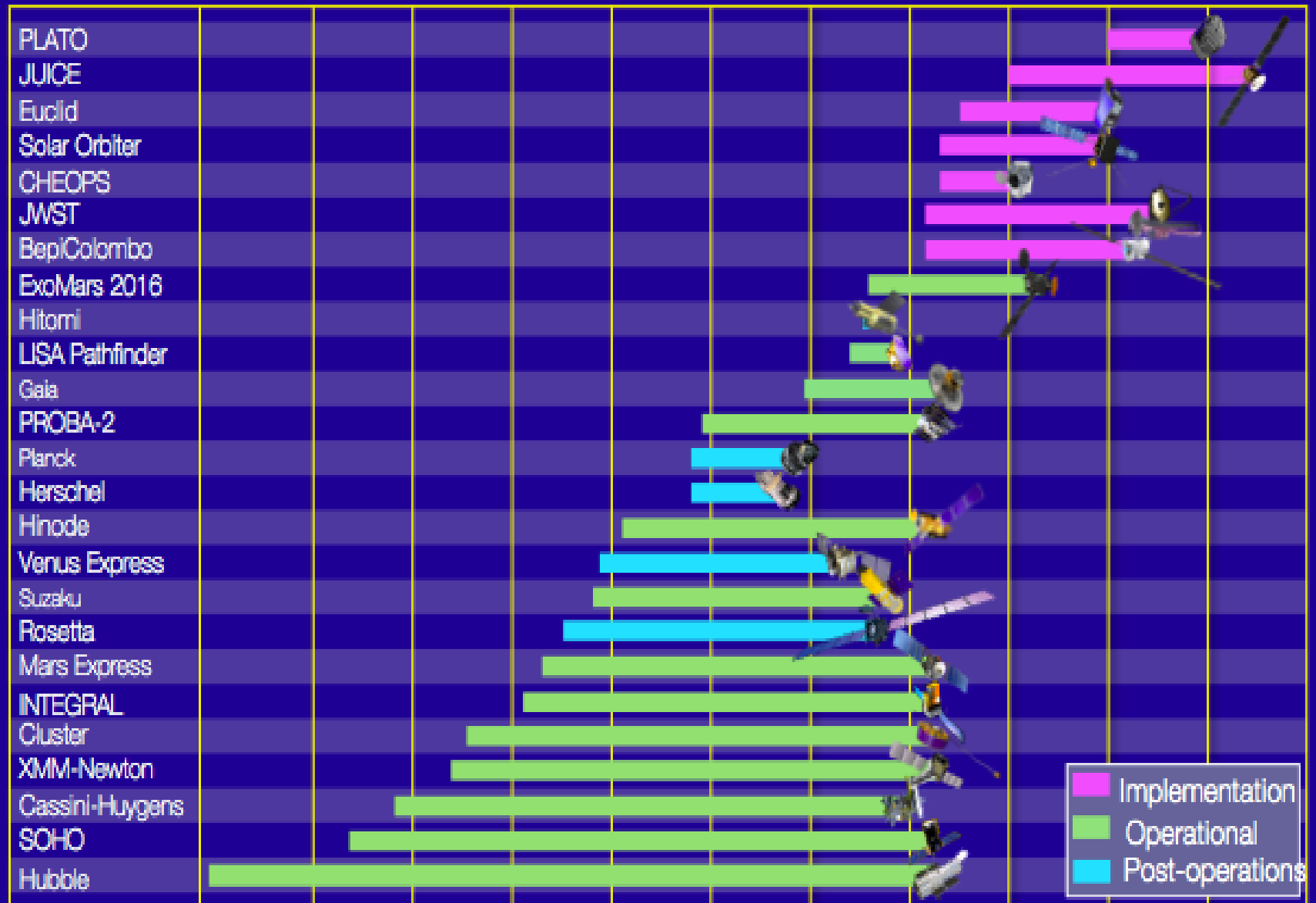
L1  
JUICE

M1  
Solar Orbiter

JWST

**X-RAY**  
L2  
ATHENA +

# ESA Space Science Missions





# Possible E3P Mission Roadmap (detailed version)

- Astronaut Mission
- E3P Core Mission
- Mission of Opp.

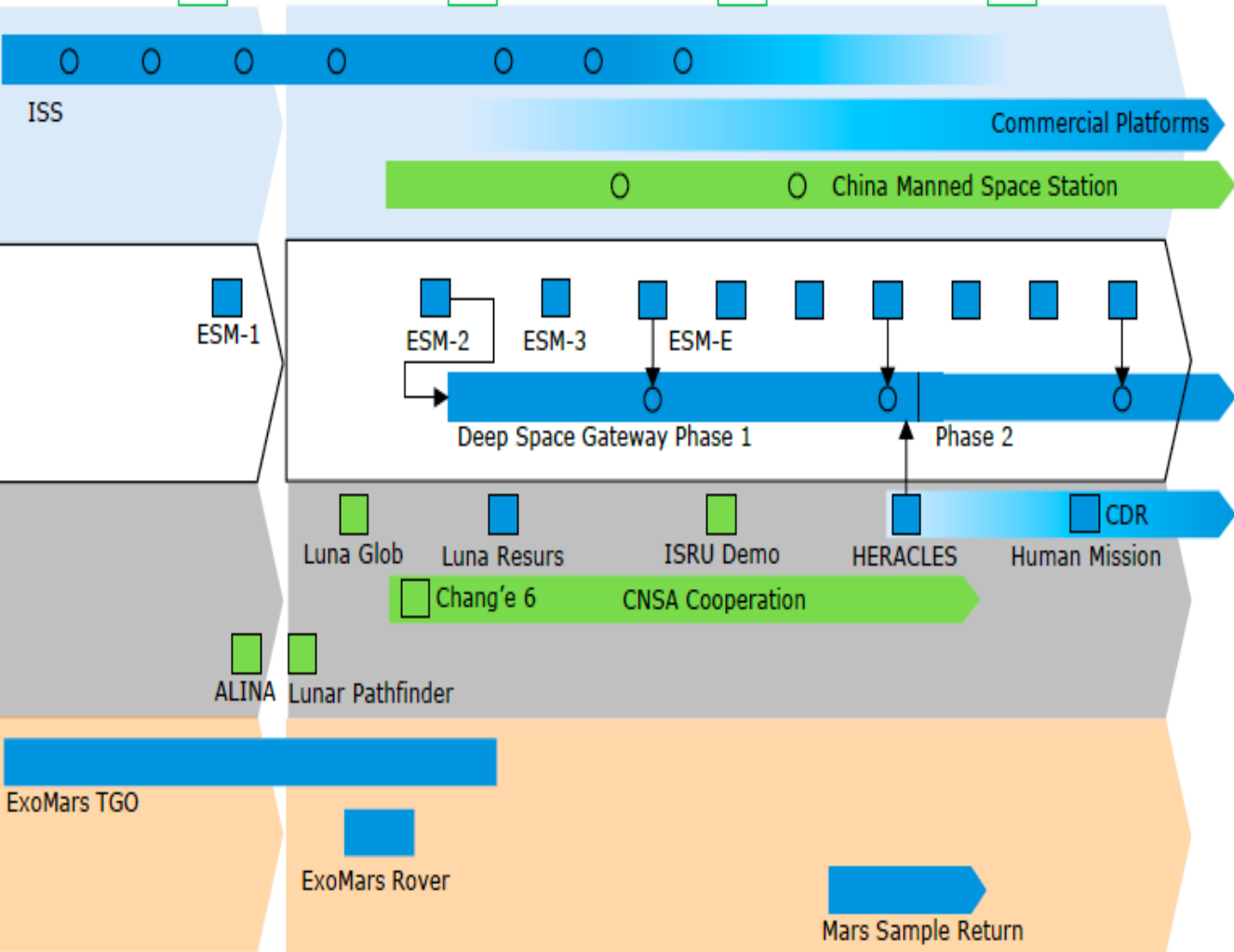
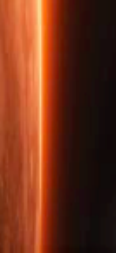
2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030

LEO

Cislunar

Moon

Mars



Exploitation of LEO Platforms

Exploration Beyond Earth Orbit

Human Exploration of the Moon

Human Exploration of Mars



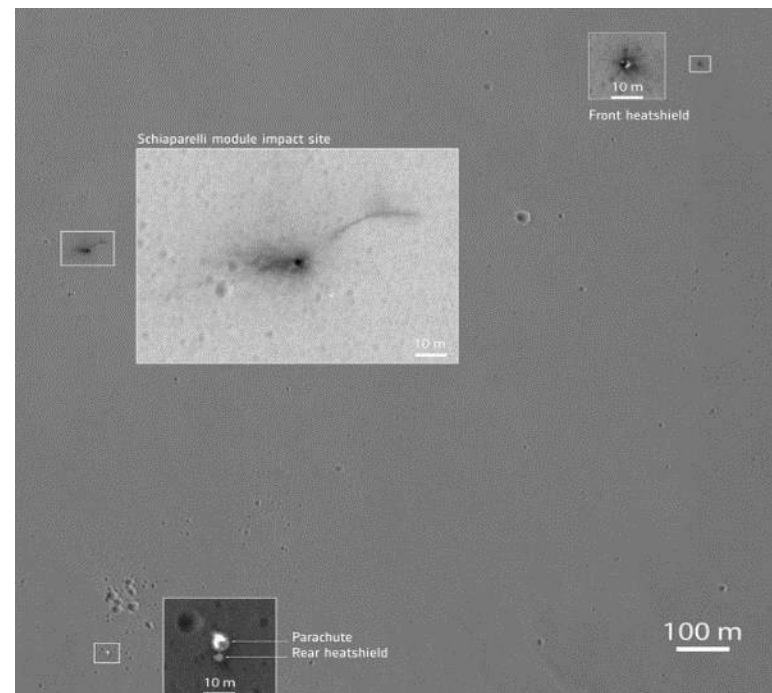
# EXOMARS : Trace Gas Orbiter and EDLM



The EDLM Schiaparelli module has provided technology validation for entry and descent but not for landing ...due to premature end of the descent sequence following software problem

- TGO: Launched on 14 March 2016. Effective mission from December 2017 until end of 2022. Orbiter will serve as relay for the 2020 rover mission

- will study the Martian atmosphere for evidence of biological gases (CH<sub>4</sub>, etc)
- A year later it had completed another set of important science calibration tests before embarking on a year of aerobraking until March 2018.



# EXOMARS : Trace Gas Orbiter

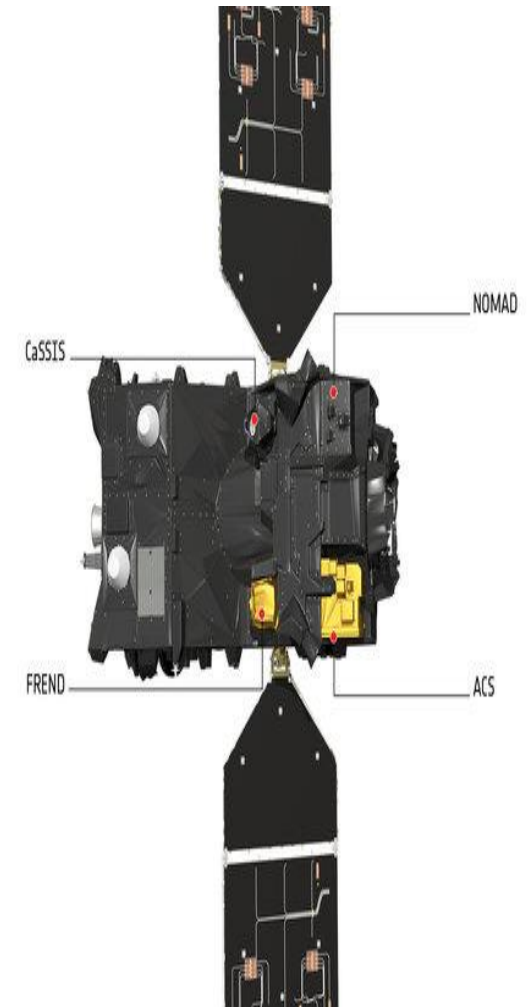


## TGO Payload :

- **ACS** (Atmospheric Chemistry Suite),
- **CaSSIS** (Colour and Stereo Surface Imaging System)
- **NOMAD** (Nadir and Occultation for MArS Discovery).
- **FREND** (Fine Resolution Epithermal Neutron Detector)

## Science :

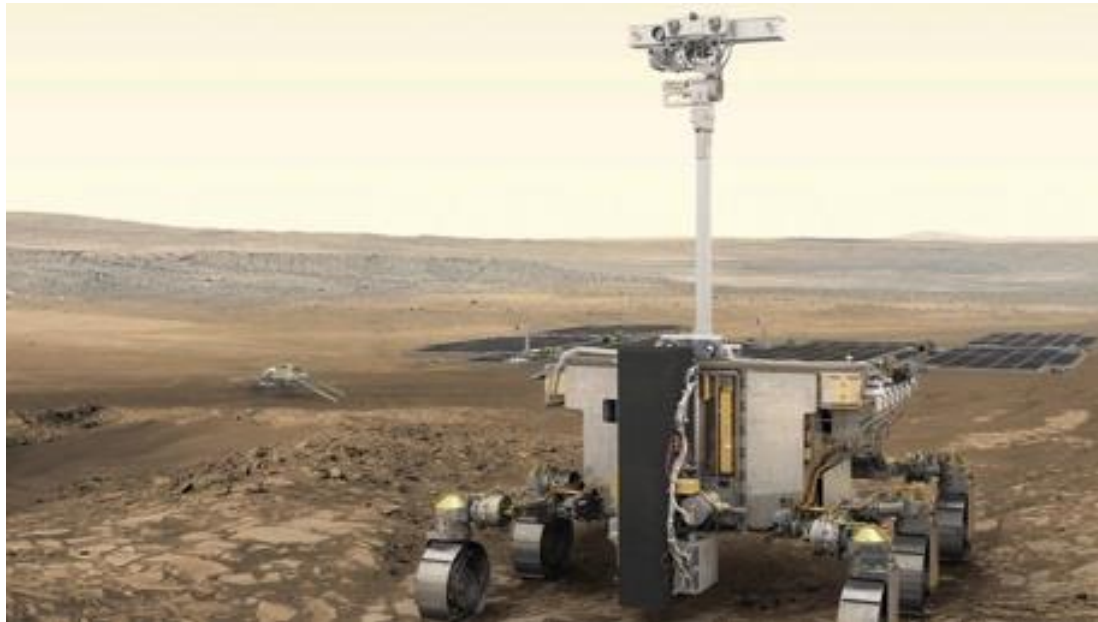
- **ACS** and **NOMAD** spectrometers with complementary frequency range will provide for the atmosphere:
  - Inventory of Mars trace gases
  - monitor seasonal changes in the composition and temperature
  - detect minor constituents
- **CaSSIS** will image and characterise features on the martian surface that may be related to trace-gas sources such as volcanoes.
- **FREND** will map subsurface hydrogen to a depth of 1m to reveal deposits of water-ice hidden just below the surface,



# EXOMARS :

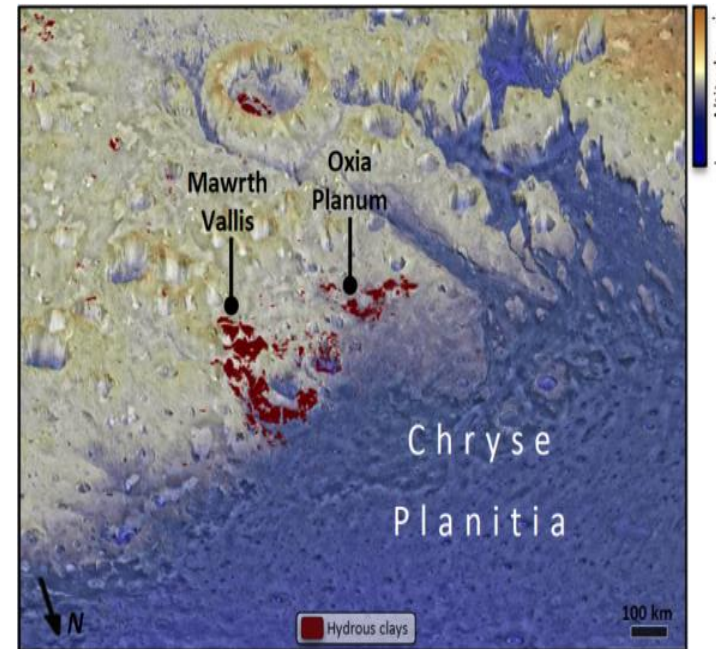


## 2020 ExoMars rover and surface science platform



2020 Rover advanced rover that will carry out the first sub-surface investigations of Mars in order to answer questions about whether life could or ever did exist on the Red Planet

- Two low-level ancient landing sites have been selected in March 2017 for the 2020 ExoMars rover and surface science platform: Oxia Planum and Mawrth Vallis.





# LUNAR EXPLORATION

## EXPLORATION



ESA contribution to Roscosmos lunar missions

- Luna-Glob (Luna-25) lander : launch confirmed end 2019, to launch in 2025...
- Luna-Resurs lander (or Luna 27), a south polar lunar lander, launch now end 2022.
- Towards a fully robotic lunar base
- For eventually a lunar human base (« Moon Village »)

PROSPECT is a drilling, sampling, sample handling, processing and analysis package under development by ESA for the Russian Luna-27 mission; scheduled for flight to the Lunar South Polar region in 2020.



*Group picture at the PROSPECT Operational Workshop*



# THE SPACE PROGRAMME WITHIN THE EUROPEAN COMMISSION





## **Interactions with European Union and Commission**

- ESSC contribution to the European Space Strategy Consultation
- Contribution to the EC DG GROWTH Horizon 2020 SPACE Cons. Workshop
- Invitation to EC H2020 Space Programme Committee to present ESSC position on draft Work Programme
- Science is global : European Parliament
- Contributions European Space Week – Space InfoDay

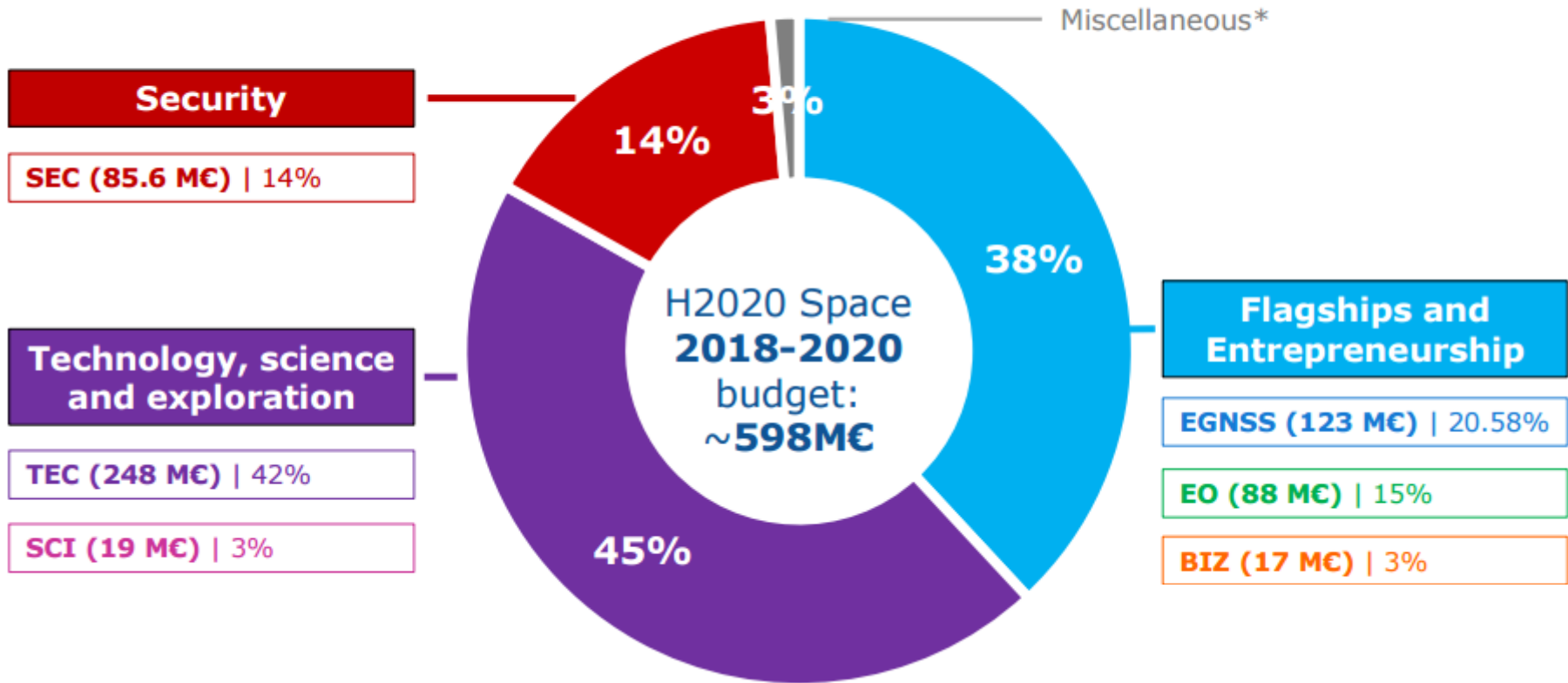
## **2018-2020 Space Work Programme (call) open**

- Part of the *Leadership in Enabling and Industrial Technologies* Pillar
- 598M€ (~USD 694M) over three years

## **Space is also relevant to other H2020 programmes**

- E.g. Environment, Infrastructure

## Indicative budget breakdown (2018-2020)



## WP 2018-2020 building blocks

### Maximising benefits of space for society and EU economy

#### SPACE-EO

- EO market uptake
- Copernicus mission and services evolution
- International coop.
- Big data

#### SPACE-EGNSS

- EGNSS market uptake
- EGNSS infrastructure, mission and services evolution

#### SPACE-BIZ

- Support to space hubs
- Space outreach and education
- Horizon Prize for European low-cost space launch
- Innovfin Space Equity Pilot (ISEP)
- SME Instrument
- Fast-track to Innovation

### Globally competitive and innovative space sector

#### SPACE-TEC and SPACE-SCI

- Technologies for European non-dependence and competitiveness
- Strategic research clusters
- Generic space technologies
- EO and SatCom technologies
- In-orbit validation/demonstration

- Scientific instrumentation and technologies enabling space science and exploration

### Access to space & Secure and safe space environment

#### SPACE-TEC

- Access to space

#### SPACE-SEC

- Space weather
- Exploring concepts for space traffic management
- Space Surveillance and Tracking (SST)
- Near Earth Objects

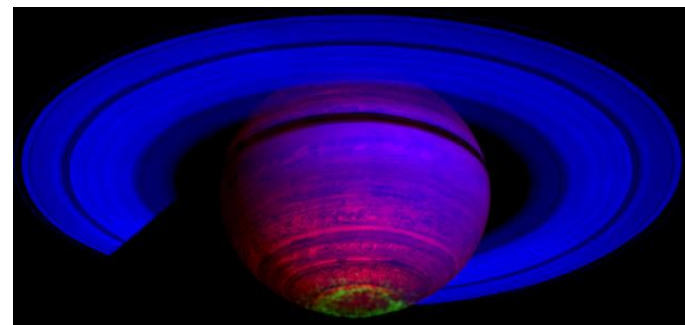
- After 2020, support to space activities is expected to be reinforced:
  - FP9 pillars
  - Joint Technology Initiative for space
  - European Institute of Innovation and Technology (EIT) - Knowledge and Innovation Community (KIC) for space



## **Europlanet 2020 RI and Follow-up**

- €10Mion Research Infrastructure Programme
  - EC-Funded (third period)
  - Transnational Access
  - Research Activities
  - Networking activities
  - Dissemination, awareness raising, Outreach
  - EPSC
  - A. Coustenis (deputy Coordinator) and N. Walter in the management scheme.
  - Sustainability Plan: Membership organisation supported by Europlanet Board – 2018 – To be hosted by ESF.

eur  **PLANET**



ESA UNCLASSIFIED - For Official Use



## PLAN

ENVISION Strategic Plan



Prepared by

Alessandro Bergamasco

Reference  
Issue/Revision  
Date of Issue  
Status

ESA  
ESA-HSO-K-PL-0011  
1.0  
26/09/2017  
Issued

European Space Agency

- Virtual Institute for Space Exploration
  - 'European SSERVI'
  - Primary purpose is to foster multi-disciplinary research, driven by exploration challenges and opportunities
  - Precise plan to be defined

- Significant coordination activities for European astrobiology in the past years
  - Community more mature and interested in a programme coordination platform
  - EAI Member organisations would be institutional
  - Streamline programmatic approach, leverage support
  - Hosted by ESF
  - Preparatory work on-going: proto-board set-up and meet Nov. 10

## Space 4.0 : Industry-Academia

### 28 Sept. 2017 and ongoing 2017, ESA/HQ

- In relation with ESA DG strategy presented at C-MIN 2016
- One of the actions attached to the vision is particularly relevant to ESSC, this Action 1.b: *New and renewed partnerships with European academia and research centres:*
  - Implement an "ESA Initiative fostering cooperation between European academia and industry for innovation and sustainability in space activities" and **establish a renewed relationship with academic and research institutions, including exchange of personnel."**
  - **Enhance and structure the cooperation between European academia and research centres on one hand and industry on the other hand**, with ESA as the third element in a "virtuous triangle" and set up a regular trilateral forum in order to coordinate R&D agendas and roadmaps.
- ESSC input on a consultation on Industry-Academia relations : document in preparation, discussions with P. Messina of Member States Office (since September)

## Space 4.0 : Industry-Academia

### **ESSC Working document stresses:**

- Academic world in Europe is multifaceted, national, institutional and disciplinary specificities should not be overlooked
- Industry should be considered in its broad sense, beyond the traditional aerospace industry
- Research organisations and industries work at a different pace and have different time horizon
- Graduate and post-graduate training in Europe does not help common understanding between engineers and academic scientists

### **Way forward:**

- Training Schemes and support to early career
- ESA-sponsored studies and projects
- Events/Networking



# ESSC and International partners



## Interactions with international space-related bodies and non-EU agencies or Institutions

- COSPAR CSAC (CNES, Paris)
- Interactions with CAS, CAST, IKI and JAXA
- And of course NAS SSB

## Collaborations : SSB of the US NAS



- Long-term constructive interactions and international exchanges/information
- Mutual Ex-Officio representation
- Joint reports and activities
- Current projects
  - **Phobos Planetary Protection Study & PPOSS**
- ESSC participating in SSB committees at the Space Science Week (28-30 March 2017)
- **ESSC Chair at the SSB Meeting in Washington on 2-4 May 2017 and CAPS on 12 Sept. 2017.**

*SSW 2017: Participation and contribution in the Plenary Session and in CAPS, CBPSS, CESAS meetings*

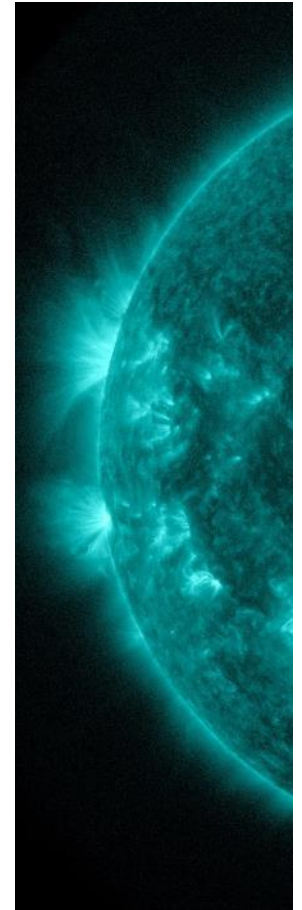


# ESSC ongoing and future activities

# ESSC European SWx Assessment and Consolidation Working Group

- **Prof. Hermann Opgenoorth, Chair, IRF, Uppsala, Sweden - ESSC**
- **Prof. Bob Wimmer-S. Vice Chair, University Kiel, Germany - ESSC**
- Prof. Mike Hapgood, RAL, UK,
- Prof. Mauro Messerotti, INAF Trieste, Italy,
- Prof. David Berghmans, ROB Brussels, Belgium,
- Prof. Jean Lilensten, IPAG Grenoble, France
- Prof. Mark Lester, Univ. Leicester, UK
- Prof. Manuela Temmer, Univ. Graz Austria
- Dr. Kirsti Kauristie, FMI, Helsinki, Finland
- Dr. Anna Belehaki, NOA, Athens, Greece
- Prof. Michael Hesse, Birkeland Centre, Bergen, Norway (former director of GSFC Heliophysics and CCMC)

Ex-officio: Dr. Juha-Pekka Luntama, ESA SSA-SWE, Dr. M. Ljungqvist EC-DG Growth, and Dr. G. Peter, EU-JRC (ISPRA)



## Statement of Work (excerpt)

- The difference between Space Weather and other natural hazards is that - while the threat is truly global and affecting large parts of the globe for each solar storm - **the detailed impact of a SWx-event can be very different from country to country, depending on the event itself**, and the details of the particular vulnerability and connectivity of national and (over-)regional infrastructures.
- In **Europe this discussion is further complicated by the fact that there are a variety of national interests**, particular vulnerabilities and specific abilities, which determine each country's individual approach to the Space Weather problem.



# ESSC European SWx Assessment and Consolidation Working Group



- **At the same time two European organisations, the ESA and the EC have in partnership with other global players recognized the SWx risk for Europe as a whole.**
- They are at present - more or less independently - pursuing the preparation of initial European Space Weather prediction services and over-regional mitigation efforts.
- **Any European progress should notably be part of a global effort**, very much in the sense of the recent ILWS/COSPAR Space Weather roadmap (Schrijver et al. 2015), which also has been adopted as the baseline for global space weather efforts as pursued and closely monitored by the UN-COPUOS Expert Group on Space Weather.

# ESSC European SWx Assessment and Consolidation Working Group



- The aim of this new committee is to prepare **detailed recommendations for a consolidated and strategic European approach to SWx**, within which we can identify the appropriate efforts and investments that need to occur in all parts of the SWx “progress iteration loop” , which is defined by
  - a) new science understanding
  - b) the improved potential to deliver SWx products (based on the most recent science findings)
  - c) evolving requirements of European end-users and infrastructure providers

*(b) and c) are then feeding back to new requirements on science understanding*



*Initiated from discussions between the European Space Sciences Committee and the European Marine Board, followed by discussions with ISSI, Paris Lettres res. Univ., ESA and support from SSB-CAPS*

# *ExOceans*

## *Science Strategy for Space Exploration of the Outer Solar System Icy Moons Oceans*

**13 November 2017 – Paris Observatory**  
***Salle de l'atelier, 77 Av. Denfert-Rochereau, Paris***

**9.00-9.30**

### **Welcome address**

Dr. Athena Coustenis, Paris Observatory, ESSC Chair

**9.30-10.00**

### **The origin of life on Earth and elsewhere**

Prof. Jan de Leeuw, NIOZ (The Netherlands)

**10.00-10.30**

### **Life in marine extreme environments: examples from geological record**

Dr. Barbara Cavalazzi, University of Bologna (Italy)

**10.30-11.00**

### **Simulation experiments: the key for finding evidence of life in the sub-surface exooceans**

Dr. Karen Olsson Francis, Open University (UK)

**11.30-12.00**

### **Habitability environments across the solar system: An Oceans Worlds Exploration Strategy**

Dr. Alexander Hayes, Cornell University (USA)

**12.00-12.30**

### **Geodynamics of icy moons**

Dr. Gabriel Tobie, University of Nantes (France)

**12.30-13.00**

### **Saturn's moons: Titan and Enceladus**

Dr. Christophe Sotin, Jet Propulsion Laboratory (USA)

**14.15-14.45**

### **NASA Europa Lander Science Definition Team Report and Mission Concept**

Dr. Kevin Hand, Jet Propulsion Laboratory (USA)

**14.45-15.05**

### **Characteristics and programmatic feasibility of radioisotope power systems for space exploration: applicability for icy moons and exooceans**

Dr. Markus Landgraf, ESA (The Netherlands)

**15.05-15.35 Technical advances to explore OCEANS - concepts and case studies from ROBEX**

Dr. Franz Wenzhöfer, Dr. Sascha Flögel and Dr. Stefan Sommer, GEOMAR and AWI (Germany)

This study is organised by the European Space Sciences Committee of the European Science Foundation ([www.essc.esf.org](http://www.essc.esf.org)).



This event is sponsored by:





## Science case:

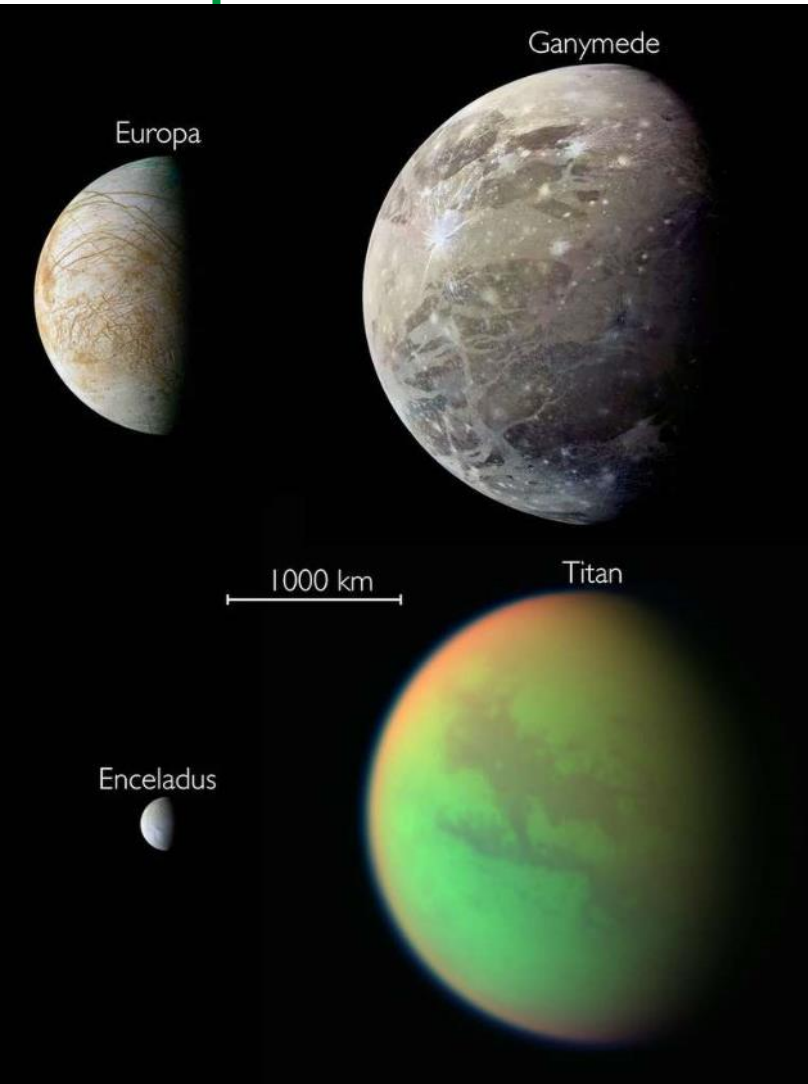
- Review and synthesize the current status of astrobiological knowledge about the **worlds in the outer solar system with possible subsurface liquid water oceans**.
- Bring together our understanding **from planetary exploration and Earth sciences**
- Bring forward future investigations needed to improve our knowledge of waterworlds from **space, ground and laboratory work**
- Lead to a better understanding of the **emergence of life** on Earth and initial conditions in the **oceans**
- Identify **mission concepts** or payload that can make the most appropriate and useful measurements, and evaluate our ability to interpret mission data and support further exploration.

## Workshops

- Three workshops – 8-12 months study
  - One 'State of the Art' workshop of the Core WG : 13-14 November 2017, Paris with participation from SSB-CAPS
  - One larger multidisciplinary workshop at ISSI
  - One final writing meeting of the WG

## Outcome

- a book within the Space Science Series of ISSI
- A policy briefing



- For producing long-term climate data records satellite data from current, historical and future missions need to be combined.
- This imposes some significant challenges on radiometric accuracy and consistency among the various missions.
- **Strong Interest from the Earth Sciences Panel to discuss and make recommendations on the quality (control) of Copernicus data**

# Study on microgravity user community

- ESA recently announced the award of an ESA ITT to Telespazio UK to study (in only 6 months) the scope and depth of the current microgravity user community, the providers in the landscape and how ESA provision of microgravity should evolve beyond 2020 and particularly post-ISS (2024).
- ESSC Contribution to be considered



## ESSC upcoming Events

- ESA upcoming SSAC, HESAC meetings *with decisions on mission selections (M4 in November, M5 to follow, other...) and development, as well as continuing discussions and consultations on the way forward after the Ministerial...*
- **European Space Week 2017 – EC Space InfoDay: 8-9 Nov. 2017**, Talinn, EE, G. Paar represents ESSC in panel discussion
- Space Weather Assessment and Consolidation Working Group (lead: H. Opgenoorth): **November**
- Exoceans study (lead: A. Coustenis): **13-14 November**, Paris, FR
- Intl Moon Village Workshop : **19-21 Nov**, Strasburg, FR (M. Anand)
- 54th plenary meeting in DLR Munich on **21-24 Nov. 2017**, in Oberpfaffenhofen - Thomas Hubertus/DLR is our host, SSB Director is invited
- Copernicus Support Office and Users Forum Meeting : **27 Nov.**, Brussels, BE, (A. Coustenis, P. Veefkind, N. Walter)

**<http://essc.esf.org>**